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Lehti, Hannu

2019-02

Lehti , H , Erola , J & Tanskanen , A O 2019 , ' Tying the extended family knot :
Þý Grandparents influence on educational achievement ' , European Soci
Þý 35 , no. 1 , pp. 29 48 . <https://doi.org/10.1093/esr/jcy044>

<http://hdl.handle.net/10138/326009>

<https://doi.org/10.1093/esr/jcy044>

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Tying the Extended Family Knot—Grandparents' Influence on Educational Achievement

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Submitted January 2018; revised September 2018; accepted October 2018

Abstract

In present-day western societies grandparents and grandchildren have longer years of shared lifetime than ever before. We investigate whether children with more grandparent resources have a higher probability of achieving the general secondary degree compared with children with fewer resources, or whether shared lifetime with grandparents increases the probability of achieving the general secondary degree. We use high-quality Finnish Census Panel data and apply sibling random and fixed-effects models that also control for all unobserved factors shared by siblings. Grandparents' education and socioeconomic status have only a limited ability to explain a grandchild's educational achievement. However, the sibling fixed-effects models reveal that every shared year between grandparents and grandchildren increases a grandchild's likelihood of completing general secondary education by 1 percentage point, on average. The effect of shared lifetime is conditional on grandparental type, family resources, and the size of the extended family. Maternal grandmothers have a positive effect on grandchildren's education in low-income families. Paternal grandmothers provide a link to the resources available through the extended family network, independent of their own resources. The same effects were not observed for grandfathers.

Introduction

One of the key questions in the social stratification literature has been to what extent and why do parental socioeconomic characteristics (i.e. educational attainment, occupational status, or income) correlate with those of their children (Bourdieu, 1977; Becker and Tomes, 1986; Ganzeboom, Treiman and Ultee, 1991; Hout and DiPrete, 2006). However, recently these two generational scopes have broadened, and a number of scholars have begun to investigating the potential multi-generational aspects of social stratification, particularly regarding whether the socio-economic position of the grandparents is associated with the position of a

grandchild (Warren and Hauser, 1997; Erola and Moio, 2007; Chan and Boliver, 2013; Hällsten, 2014; Ziefle, 2016).

Multigenerational stratification studies have investigated whether grandparental social class (Beck, 1983; Erola and Moio, 2007; Chan and Boliver, 2013; Hertel and Groh-Samberg, 2014), earnings and income (Warren and Hauser, 1997; Loury, 2006; Zeng and Yu, 2014; Lindahl *et al.*, 2015), or cultural capital (Møllegaard and Jæger, 2015; Ziefle 2016) have a direct effect on grandchildren's outcomes. However, these previous studies have shown mixed results. Although some have found that grandparental status correlates with grandchild's

status, net of parental status (Modin, Erikson and Vågerö, 2012; Chan and Boliver, 2013), others have found that the effect is either very small or negligible (Warren and Hauser, 1997; Erola and Moisio, 2007; Jaeger 2012; Bol and Kalmijn, 2016; Ziefle, 2016). These mixed results indicate that despite of their obvious strengths, previous multigenerational stratification studies also have their limitations.

We argue that one of the limitations of the literature, and a potential reason for the mixed results, may simply be the inability to differentiate the three types of mechanisms involved. First, grandparents can directly transfer resources across generations, which is also called a *legacy* effect (Mare, 2011). Second, grandparents' resources may provide *stability* for the nuclear family especially in the times of need and/or when parents have separated (Bengtson, 2001). To our knowledge, there has been only one previous study (Knigge, 2016, using historical Dutch data) that has attempted to differentiate the effects of these two mechanisms.

However, in addition to studying the importance of these previously studied mechanisms, we also consider a previously largely unexplored mechanism. We argue that the grandparents do not necessarily need to provide anything directly to the grandchildren themselves but may simply provide a tie between them and other extended family members that would not exist otherwise. This tie enables resource transfers from the extended family network to the grandchildren. If this is the case, the shared lifetime between grandparents and grandchildren should simply have a positive correlation with grandchildren's education attainment. This *exposure mechanism* could be important even when grandparents themselves could not, or would not be willing, to provide any resources to their grandchildren.

We suggest two sub-hypotheses about the exposure mechanism that have not been considered in previous studies. First, if the exposure has an effect on educational attainment as a result of the grandparents providing a link to the extended family, this effect should become stronger as the family network grows. The second sub-hypothesis for the exposure mechanism has been suggested in the literature on human evolution. Because women are found to be more involved with family relationships and promote interaction, especially among their female kin, compared with men (Dubas, 2001; Dubas, 2001; Bracke, Christiaens and Wauterickx, 2008; Sear and Coall, 2011), grandmothers may also demonstrate a stronger commitment to their grandchildren compared to grandfathers, behaving as *kin keepers* within the kin network (Astone *et al.*, 1999; Coall and Hertwig, 2010). In this study, we compare the

importance of these explanations of grandparent effects in Finland. To do this, it is necessary to have efficient ways to exclude the potential influence of the Markovian processes, that is, the intergenerational influences transmitted through the parental generation in between rather than directly from grandparents to grandchildren. We investigate the association between different grandparents' resources, shared lifetime with grandchildren, and educational achievements with sibling random and fixed-effects models, using high-quality Finnish register data.

Theoretical Background

Legacy, Stability, and Kin Keeper Effects

Because of the increase in longevity in contemporary western countries, grandparents may be more influential in grandchildren's attainment than ever before (Bengtson, 2001). Population aging means also that the total number of older adults, and thus, potential grandparents are increasing. Mare (2011) has argued that because of increasing longevity and fewer descendants, grandparental resources that can be directly transferred from grandparents to grandchildren, also called *legacy effects*, should matter more than before. The evidence for this type of grandparental influence seems to be fairly consistent. An extensive review by Bol and Kalmijn (2016) indicates that if any grandparent effect was found in the previous multigenerational stratification studies, they were mainly limited to grandfathers who likely to had a higher social status and higher income than grandmothers. In Finland, while Erola and Moisio (2007) found the overall grandparent effect rather small, they did find statistically significant grandparent-grandchildren associations among the service class and among farmers, which are both potential indicators for the inheritance of family land or wealth.

Additionally, the influence grandparents have on educational outcomes among grandchildren may be related to the educational level attained by the grandparents themselves (McNeal, 2001; Loury, 2006). Compared to grandparents without academic qualifications, those with academic credits more probably have socioeconomic and cultural capital that they can transmit to their offspring (Mare, 2011; Møllegaard and Jæger, 2015). Further, high-status grandparents who are well connected and have wide social networks can use their social capital for their grandchildren's advantage or may simply act as positive role models for the grandchildren (Hällsten, 2014). Therefore, the first hypothesis states the following:

Hypothesis 1 (H1; Legacy hypothesis): Socio-economic resources of the grandparents are positively associated

with grandchildren's educational attainment, regardless of the parents' resources.

Bengtson (2001) has underlined the potential *compensatory* role of grandparents for replacing the missing relationship stability and material resources of the immediate family, resulting mainly from high divorce rates and material deprivation. Indeed, several studies have shown that grandparents can increase the wellbeing of their grandchildren particularly in socially and financially unstable family conditions (Tanskanen and Danielsbacka, 2019). Our second hypothesis follows this reasoning and states:

Hypothesis 2 (H2; Stabilizer hypothesis): The socio-economic resources of grandparents are positively associated with grandchildren's educational attainment when parental resources are low or parents have separated.

Research has shown that grandparents are highly involved in their grandchildren's lives still in the modern western societies (Hank and Buber, 2009; Igel and Szydlik, 2011). Moreover, there is consistent evidence showing that the involvement of grandparents correlates with several outcomes for children, such as increased academic achievements (Falbo, 1991), better cognitive development (Sear and Coall, 2011; Tanskanen and Danielsbacka, 2017), and improved psychological well-being (Lussier *et al.*, 2002; Tanskanen and Danielsbacka, 2012; Tanskanen, Erola and Kallio, 2016).

Exposure Effect

One could expect that being in contact would increase grandparents' influence on grandchildren. However, the evidence regarding the type of contact required in resource transfer between grandparents and grandchildren is not consistent. Zeng and Yu (2014) did find that in rural China grandparents had a positive effect on children's academic attainments only when grandparents, parents and grandchildren lived together in the same household. On the other hand, according to previous studies in the United States and The Netherlands, physical proximity does not seem to matter (Jaeger, 2012; Bol and Kalmijn, 2016). Knigge (2016) used the presence of a grandparental generation (great-grandfathers vs. grandfathers) as a proxy for contact explaining grandchildren's status attainment in The Netherlands 1812–1922. The life expectancy was so low in The Netherlands that the great-grandfather rarely had any overlapping years alive with the great-grandchildren. Despite this, both the great-grandparents appeared to have a direct influence on the great-grandchildren's

status. Therefore, perhaps a more realistic assumption is that if the grandparents are still alive when the grandchildren are born, some contact tends to exist.

Hypothesis 3 (H3; Exposure hypothesis): The greater number of overlapping years between grandparents' and their grandchildren's lives, the stronger the grandparents' influence on the grandchildren's educational attainment, net of parental resources.

However, it might also be that previous studies have assumed too much. It may be that the grandparents themselves do not provide any resources to their grandchildren but are still a necessary part of the intergenerational transmission. Previous studies have underlined the importance of other extended family members, such as aunts and uncles, in regard to children's educational attainment (Jaeger, 2012). The extended family network provides a pool of resources that may become especially valuable at times when the parents lack such resources (Coleman, 1991; Milardo, 2010; Lehti and Erola, 2017). In fact, it may be that the often observed, but weak, grandparent effect is actually due to unobservable effects of the contributions made by other extended family members.

This pool of resources, however, does not exist by chance. The necessary link between extended family members may be the grandparents. The existing research on family ties suggest that a sibling tie is considered as a less obligating one than those between parents and children, or those between spouses (Rossi and Rossi, 1991; Connidis and Campbell, 1995) and that the ties between siblings tend to become weaker after parental death (Connidis and Campbell, 1995; White, 2001; Khodyakov and Carr, 2009). If the grandparents were needed to maintain the extended family network, the positive grandparent effect would not need to depend at all on the resources of the grandparents, but simply on how long they remain to maintain the network. Thus, the length of the overlapping lives of grandparents and grandchildren would simply have a positive effect on grandchildren's adult outcomes. This could also explain why proximity or the amount of contact does not seem to matter for grandparent effects. The extended family network exists because of the existence of the grandparents, not because of their whereabouts or their ability or willingness to invest in grandchildren. Thus, based on these assumptions, we expect that:

If the grandparent is a necessary link between the extended family members, the exposure effect may become stronger as the extended family network grows. That is, by having a greater number of extended family relationships, there should be a greater probability that at least some of the extended family members would

have a positive impact on the children's educational attainment. Thus, the first hypothesis about the exposure effect is as follows:

Hypothesis 3a (H3a; Extended family network hypothesis): A larger extended family network increases the effect of a shared lifetime between grandparents and their grandchildren, net of parental resources.

However, other theories would predict an opposite interaction between the exposure and the size of the family network. If the grandparent effect is dependent on the family's ability to make investments in their ancestors (and thus dependent on their scarce resources), the extended family network can *reduce* the influence of the grandparents because of the greater dilution of the investments. For instance, Coall *et al.* (2009) have shown the dilution effect to be associated with the solicitude of the grandparents on their grandchildren.

Grandparental exposure is also likely to have differential effects depending on the grandparental type. Because of psychological, biological, and sociocultural factors, women typically interact with their kin to a greater extent than men (Dubas, 2001; Bracke, Christiaens and Wauterickx, 2008). These gender-based grandparental differences are explained by women's roles as 'kin keepers' within the family network. Indeed, previous studies have consistently shown that, compared to grandfathers, grandmothers tend to invest more economic and material resources and time to their grandchildren and, in particular, that maternal grandparents tend to invest more than paternal grandparents (Pollet, Nettle and Nelissen, 2006, 2007; Danielsbacka *et al.*, 2011). The investments of grandmothers, and maternal grandmothers in particular, may also increase the grandchild's well-being to a greater extent than those made by grandfathers (Sear and Mace, 2008; Sear and Coall, 2011; but see Tanskanen and Danielsbacka, 2017). Furthermore, in line with a compensatory mechanism, children in families with low resources may benefit more from the involvement of their maternal grandmothers compared to children in high-status families, because the children in the latter group simply do not require additional benefits from outside of their immediate families (Sear and Coall, 2011).

These gender differences among grandparents that suggest grandmothers—and particularly maternal grandmothers—are more inclined to invest in their grandchildren lead to the second hypothesis regarding the exposure effect.

Hypothesis 3b (H3b; Kin keeper hypothesis): Increased shared lifetime with maternal grandmothers should

benefit grandchildren's educational achievement net of parents' resources, especially families with low socio-economic resources.

Finally, if the effects of the previous generations vary by kin, it might also be that the exposure effect varies by the lineage. If women are indeed the important kin keepers, then the grandparents are not needed as much as a tie between the immediate and extended families, if mothers tend to keep in contact with their own relatives in any case (see Milardo, 2010, 25–29). If this is the case, the exposure effect of the grandparents could be stronger on the paternal side.

Research Design

Methods

Our outcome variable is binary, indicating whether a grandchild has acquired a general secondary education by age 20. To test our hypotheses, we apply two different types of multilevel linear probability regression models (LPMs). These models do not suffer from the unobserved variable bias like the logistic models often applied with binary outcomes, which is why the LPM coefficients are comparable between models and groups (see Mood, 2010). Further, LPMs allow us to interpret interactions as they are interpreted in any linear regression models, something that is not that straightforward in the case of the logistic models (see Ai and Norton, 2003). A misspecified functional form for a binary outcome is a commonly assumed problem of LPMs. However, we follow the argument by Mood (2010) that an LPM is a preferred choice over logistic regression if the linearity assumption does not change the results substantially. To make sure this is truly the case here, we computed our main effect models also with logistic regression (see Online Appendix Table A4a and b). The results show no differences to the LPMs presented in the main text.

One of the biggest problems for identifying the 'true' effect of grandparents on grandchildren's educational attainment is the confounding Markovian processes that often remain unobserved. These processes refer to the influences of the grandparents that are transmitted through the generation between grandparents and grandchildren. Usually, the problem is approached by using random effects models and controlling for some of the observed socio-economic characteristics of the parents. However, some important Markovian processes would still be omitted, such as, for instance, the effects of aunts and uncles (see Jaeger, 2012; Breen, 2018; Erola *et al.*, 2018).

We study the importance of *legacy effects* by fitting random effect models to the data clustered according to siblings and cousins. To exclude the influence of the Markovian processes, we follow the common procedure of the earlier literature, where observed family level variables are controlled for (see Erola and Moiso, 2007; Chan and Boliver, 2013; Hällsten, 2014; Ziefle, 2016). The full random intercept models are estimated with the following model:

$$y_{ijk} = \beta_{0jk} + \beta_{gp}EDU_k + \beta_{gp}ISEI_k + \gamma Z_{jk} + \gamma X_{ijk} + \epsilon_{ijk} \quad (1)$$

In the models, k refers to a cluster of cousins who share the same grandparent, j refers to a cluster of biological siblings who share the same parents and grandparents, and i refers to an individual within both clusters. Intercept β_{0jk} gives mean β_{00k} and random variation u_{jk} between sibling ($\beta_{0jk} = \beta_{00k} + u_{0jk}$) and mean γ_{000} and random variation v_{00k} between cousins ($\beta_{00k} = \gamma_{000} + v_{00k}$). $gpEDU_k$ refers to the grandparent educational in years variable. $gpISEI_k$ is grandparents' socio-economic status measured by ISEI-scale. γZ_{jk} refers to the vector of specific control variables at the family level and γX_{ijk} at the individual level. ϵ_{ij} refers to the individual-level variance within families.

To test the *stabilizer hypothesis*, we also include interaction terms between parental resources/divorce and grandparental resources. Note, however, that the scales of the education and ISEI variables differ, which is why the sizes of the estimates are not directly comparable. Thus, to determine the strongest interaction effect, we plot every interaction and interpret how strong the interaction is in a statistical sense (i.e. statistically significance), and how strong it is substantially (in terms of practical importance).

In the case of the *exposure effects*, we apply sibling fixed-effects models that control for any observed or unobserved factors shared by siblings. This strategy removes entirely the problem of unobserved heterogeneity at the family level. Because of this, it can also be argued that the fixed-effects analyses provide more causal estimates than random intercept models. The family-constant endowments that are being controlled for in these models by design include, for instance, the level of education, the cultural capital, and even some genetic factors that siblings share. Furthermore, these models control for any remaining Markovian processes, including any physical proximity between grandparents and grandchildren, because siblings share the same household and thereby have the same proximity to grandparents, assuming neither the families nor grandparents move during childhood.

However, because families and grandparents do sometimes move during siblings' childhood, we cannot entirely control for how long siblings are exposed to grandparental proximity.

The problem of sibling fixed-effects models is that only the effects of the factors that vary between siblings can be estimated. Thus, we cannot make conclusions about the importance of grandparents' (and also parental) resources that do not vary between siblings, except through the interaction effects between the factors that do vary, such as grandparental exposure. Further, families with one child do not contribute to the effects that can be estimated through the differences between siblings in the same families and are thereby omitted from the analyses.

Even though sibling fixed-effects models control for all the unobserved factors shared by siblings, the factors that vary may still bias the results and need to be taken into account explicitly. For instance, women's educational attainment has increased over time and surpasses that of men in our data. Unless controlled for, the exposure effect would be confounded with gender. Similarly, because of the educational expansion of recent decades, later-born children have a higher probability of achieving higher educational levels compared to those born earlier. This would also be correlated with the exposure effect. We control for the potential contemporary trend in education by adding the child's birth year as a covariate.

Similarly, we control for the birth order in the immediate family. Previous studies have shown that birth order among siblings may make a difference in the sense that firstborn children achieve higher success than later-born children (Conley and Glauber, 2006; Härkönen, 2013; Sigle-Rushton *et al.*, 2014). Maternal age can also be a confounding factor, as older mothers tend to have more resources (Barclay and Myrskylä, 2016), which is why we also control for maternal age at birth.

The full sibling fixed-effect models are estimated with the following equation:

$$y_{ij} = \beta_{shared_{ij}} + \gamma Z_{ij} + \alpha_j + e_{ij} \quad (2)$$

In the sibling fixed-effect models, j refers to a cluster of biological siblings who share the same parents and grandparents, and i refers to an individual within this cluster. $shared_{ij}$ denotes the shared lifetime between grandparents and grandchildren within families. Z_{ij} refers to the vector of specific sibling-specific control variables. α_j is the family-specific fixed parameter (i.e. family identification variable), which represents all the factors that are constant between siblings, and e_{ij} is the within-sibling error term.

To test whether the potential exposure effect is dependent on a specific grandparent, we first include the shared lifetime with different grandparents in the fixed-effects models. Second, to elaborate on the mechanism by a specific grandparental, we interact shared years with parental divorce and parental resources (family income, parental ISEI, and education), as well as the number of relatives (cousins and aunts and uncles). Last, as the tests of robustness, we study whether the grandparent exposure depends on the grandparent's education and socio-economic status by interacting grandparents' and grandchildren's shared lifetime with grandparents' education and ISEI.

Register Data

For our analyses, we use the register-based *Finnish Growth Environment Panel (FinGEP)* obtained from Statistics Finland. The original data set is based on a 10 per cent representative random sample of the entire population residing in Finland for at least 1 year in 1980 that is expanded with sample persons' children, partners, and partner's parents. The data are entirely based on administrative registers. They include individual-level records from censuses and administrative sources such as tax, employment, and education registers, providing information on the socio-economic, educational, and demographic characteristics of each individual included in the data. The data set runs from 1980 to 2010, containing information from the years 1980, 1985, and annually from 1987 onwards. All persons are followed until 2010, or when they dropped out of the data, either because of death or moving abroad. Unlike usual survey data, the register data do not suffer from respondents' misreporting, memory errors, or non-response.

To identify the extended family networks from the original data set, we linked all biological parents (second generation) with their children born 1972–1990 (third generation) and then further to the grandparents (first generation). This makes a three-generation data set that includes the ancestors of the first generation and family members from the second generations. To be included to our analyses, at least one of the grandparents and parents needs to be sample persons. Because *FinGEP* is based on a sample of second-generation parents, in most cases, we were able to match grandchildren only from either the maternal or paternal side. The side of the grandparent is taken into account in all models, either as an indicator variable or as separate models for each grandparental lineage. For the children included to the analyses, the data cover all their maternal or paternal cousins, aunts and uncles, and grandparents.

The final *total sample* consists of 71,551 children and 48,337 families. The sample consists of the siblings who share the same household during the follow-up period (until age 16) and live with at least one biological parent. For those cases where grandparents from both sides were included in this sample (6 per cent of the children), we randomly selected the side of the grandparent included in our data. After omitting missing values (1.3 per cent of the cases) and siblings who do not share the same household with at least one of the parents (~0.7 per cent of the cases), the imputed sample included information from 70,845 children, clustered in 47,738 families. This total sample is used in the random effects models.

The sample that is used for the sibling fixed-effects models (*the fixed-effects sample*) is further restricted to those having at least two siblings in the data. Further, because only the siblings that vary in their exposure to grandparents are informative in these models (shared lifetime with their grandparent), the data set is restricted to the clusters where at least one of the siblings experienced the grandparents' death before entering general secondary school by age 16 (see Frisell *et al.*, 2012; Sigle-Rushton *et al.*, 2014). These restrictions leave 5,117 children from 2,059 families (see Figure 1).

Finally, for the models comparing the exposure effects of different grandparents in the sibling fixed-effects models, we use the data on 6 per cent of the children that cover grandparents from both the maternal and paternal sides. This subsample (*the full information FE sample*) includes 3,053 grandchildren from 1,237 families.

Dependent and Independent Variables

Our outcome variable indicates whether a grandchild has acquired a general secondary education (*lukio* in Finnish) degree by age 20. In our total sample, 48 per cent of the children have completed general secondary education (see Table 1). In Finland, children typically enrol in general secondary school or vocational secondary school at age 16 after compulsory school which begins when children at the age of 7. Approximately 90 per cent graduate within 3 or 4 years later when they are 19. Completing general secondary school provides children with access to university level education (academic track), making it an important indicator for social stratification that takes place later in life. Education in Finland is free of charge at all levels.

In the random effects models testing the legacy effect, the main explanatory variables include grandparents' highest level of education and socioeconomic status.

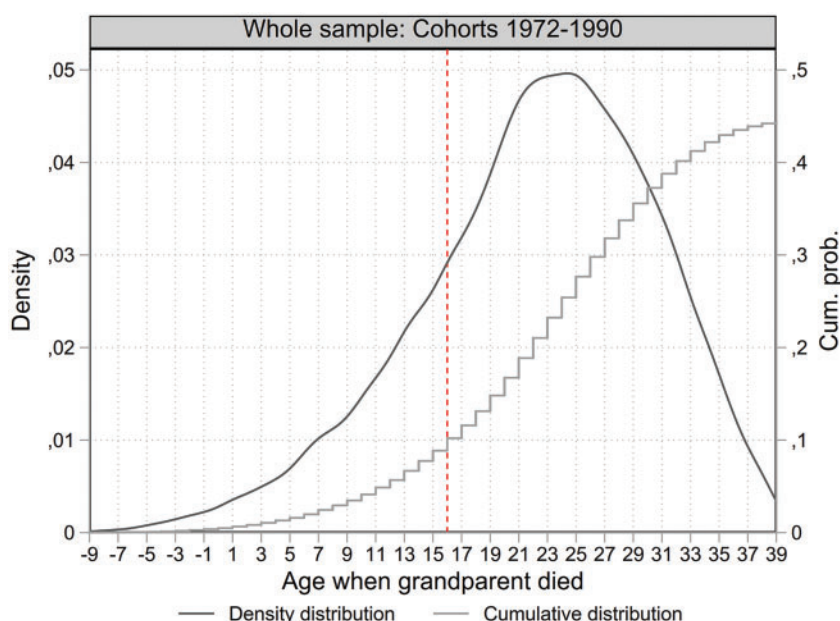


Fig. 1. Child's age at the time of grandparent's death for all cohorts from 1972 to 1990

Table 1. Descriptive statistics

Variable	Whole sample			Fixed-effects sample			
	Mean	SD	N	Mean	SD	Within Sib. SD	N
General secondary school	0.48	0.50	71,450	0.48	0.50	0.31	5,117
GP-GC shared lifetime	15.45	2.19	71,551	11.83	4.42	1.82	5,117
GP ISEI	36.12	14.91	57,281	31.73	13.07	0.97	2,873
GP education (years)	8.29	2.54	71,407	7.80	2.06	NA	5,117
Parental education (years)	11.93	2.87	71,513	11.66	2.91	NA	5,117
Parental ISEI	46.96	16.02	71,429	45.52	16.61	4.32	5,117
Non-intact family	0.31	0.46	71,468	0.27	0.44	0.17	5,117
Aunt/uncle mean education	9.91	4.16	71,551	8.94	4.48	0.26	5,117
Number of siblings	2.21	1.46	71,551	3.16	1.74	NA	5,117
Number of cousins	3.87	5.52	71,551	4.22	6.96	1.44	5,117
Year of birth	1981.80	5.01	71,551	1982.30	4.87	3.29	5,117
Yb: 1976–1990 (Ref. 1972–1975)	0.86	0.34	71,551	0.89	0.32	0.24	5,117
Firstborn	0.64	0.48	71,551	0.38	0.49	0.46	5,117
Thirdborn or later-born	0.10	0.30	71,551	0.23	0.42	0.33	5,117
Log-family income	10.83	0.48	71,087	10.79	0.50	0.16	5,117
Family income	56,739	37,793	71,088	55,157	37,226	11,876	5,117
Mother's age at birth	26.21	4.60	71,551	27.75	5.11	3.27	5,117
Maternal side	0.54	0.50	71,551	0.52	0.50	NA	5,117
Female	0.51	0.50	71,551	0.50	0.50	0.38	5,117
Rural (ref. urban)	0, 19	0.39	71,519	0.21	0.41	NA	5,117

Note: GP=grandparent; GC=grandchildren.

Grandparent's education is measured as years.¹ In our samples, the educational level of the grandparents is in general low: 76 per cent of the grandfathers and 80 per cent of the grandmothers had compulsory level education at the maximum (see [Online Appendix Figure A1](#)). The auxiliary analysis shows that Educational homogamy among the grandparents is commonplace: 71 per cent of the grandparents from the same family share the same education level.

We measure grandparental and parental socio-economic status with the International Socio-Economic Index of occupational status (ISEI scores). ISEI scores form a scale of occupations (ranging 16–90), which is constructed by regressing occupations with their income and education, thus making them closely related to both ([Ganzeboom, De Graaf and Treiman, 1992](#)). Because the ISEI scale is based on occupational data, it is less sensitive to short-term variation than income but includes more long-term variation during the different phases of life than education does. In our models, ISEI scores are *z*-standardized.

We use the latest value of grandparental education and the ISEI score observed during the period when children were 0–15 years old (before they chose the secondary education track).² If the grandparent died before the child was born and had retired after 1980 (the first year of the data set), we selected the value closest to the child's birth year. However, the occupational status is missing from every fifth grandparent (19.7 per cent) because of retirement before the year 1980. We imputed these missing values using the grandparent's income, education, and age at the grandchild's birth by using multiple imputations. [Online Appendix Figure A2](#) compares the distribution of the imputed values to the observed values. The distributions are very similar, suggesting that the imputations can be considered completely accurate.

We use grandparents' education and socio-economic status as proxies for the legacy effects; because of the high age of the grandparents and the gaps in the data, properly comparable income or wealth information was not available.

The shared lifetime between grandchildren and grandparents that is used as an indicator for the exposure to a grandparent is measured until the grandchildren reach the age of 16, which is again because the choice of secondary education track is completed by that age. In the cases where grandparents died before the grandchildren were born, the shared lifetime is coded as 0 years even if the death occurred several years before birth. It follows that the shared lifetime ranges from 0 to 16 years (RE sample: $M = 15.45$, $SD = 2.19$; FE sample: $M = 11.83$, $SD = 4.42$). Because children can have two

grandparents on each side, we provide three sets of estimates for exposure in the fixed-effects analyses: overlapping lives with the grandparent who died latest (the fixed-effects sample), the sum of overlapping lives with both grandparents from the same side (the fixed-effects sample), and separate estimates for the overlapping lives with all four grandparents in the same model (the full information FE sample).

Control Variables

In the random effects models, we control for the following variables at the family level: highest parental education in years, highest parental (standardized) ISEI score when children were 10–15 years old, parental dissolution before age 15 (dummy variable 0 = Intact family 1 = Non-intact family), aunts and uncles' mean number of years of education (when children were 10–15 years old), grandparental lineage dummy (maternal or paternal), and the number of siblings as well as cousins. At the individual level, we control for mean household taxable income³ when children were 10–15 years old (adjusted annually according to the value of the euro in 2014, log-transformed, and *z*-standardized), a dummy for whether the child lives in an urban or a rural area (latest value when children were 10–15 years old), sibling order (dummies for the firstborn and the thirdborn or later-born within sibship), the child's year of birth (a linear effect and, based on several tests of different parametrizations, a dummy to control for the nonlinearity and distinguishing two groups: 0 = 1972–1975, 1 = 1976–1990), the mother's age at birth (linear), and the child's sex.

In the sibling fixed models, we control for variables that vary between siblings: birth order, family income, child's sex, mother's age at birth (see [Table 1](#) for variables), and a child year of birth dummy coded as in the case of random effect models (0 = 1972–1975, 1 = 1976–1990). In the sibling fixed-effects models, the linear effects of year of birth of a child and maternal age are entirely collinear between siblings, so controlling for the latter also controls for the first. Note also that the same linear effect also controls for the age of the grandparents at birth in similar manner. Thus, we include only maternal age at birth as a linear variable in the sibling fixed-effects models.

In the sibling fixed-effects interaction models, we interacted shared lifetime by grandparental type with number of cousins, number of aunts and uncles, number of relatives (cousins and aunts and uncles), family income, parental ISEI, and education and family type (see descriptive statics [Online Appendix Table A1b](#)).

Descriptive Statistics

Figure 1 shows the density and cumulative distribution function of grandparents' and grandchildren's shared lifetime variable for the whole sample. The figure is based on the grandparents who died last, either on the maternal or paternal side. It shows that approximately 45 per cent of these grandparents had died by 2010, the last year of the data set. In Figure 1, the red dashed line is the cut-off point for observing grandparents' deaths in our models. It shows that for approximately 10 per cent of the children, both grandparents, from either the maternal or the paternal side, had died by the time the child turned 16.

In the sibling fixed-effects models, we have to restrict the sample to those families that have at least two children, and at least one child who experienced his/her grandparents' deaths by the age of 16. Thus, siblings vary by grandparental exposure (we omitted two-child twin families). The restrictions may influence the representativeness of the fixed-effects sample. For example, it may be that grandparental death is more common for disadvantaged, lower-status children than for others.

Table 1 presents the means, overall standard deviations, and within-sibling standard deviations of the applied dependent and independent variables for the total and the fixed-effects sample; Online Appendix Tables A1a and b provide the imputed total sample and the full information FE sample. The fixed-effects sample is somewhat downward biased according to grandparental socio-economic resources (education and ISEI) but not by the parent-level socio-economic characteristics (education, ISEI, and family income). The imputed total sample does not differ from the non-imputed total sample. In the full information FE sample, parental separation is somewhat more downward biased compared to the total and fixed-effects sample.

To test whether FE samples suffer for sample selection bias, we fitted a series of ordinary least squares regression models and compared them with the Wald test to determine whether estimates differed between the samples. Online Appendix Tables A7a and b show the results of these comparisons. The only statistically significant difference ($P = 0.0244$) between the FE and total sample is between the estimates of the year of birth dummy variable ($0 = 1972\text{--}1975$, $1 = 1976\text{--}1990$), suggesting for an underestimated coefficient in the FE sample (see Online Appendix Table A6a). This finding is likely a result of the FE sample including siblings who are more distant in age, because at least one of the siblings in the family would eventually experience grandparental death. While the estimate is smaller, the direction and the statistical

significance level are the same. The comparison between the full information FE sample and the full sample shows that the effect of family income differs between them ($P = 0.0003$). However, average family income does not greatly differ between samples (Table 1 and Online Appendix Table A1b). This suggests that while the difference is important to acknowledge, the bias is most likely too small to have substantial impact on the results.

Results

Grandparental Resources

Table 2 reports our analyses based on four random effects models, the data clustered according to siblings and cousins. The table provides all estimates and variance components between siblings, cousins and individuals (residual), as well as intraclass correlations for siblings and cousins. Model 1 is a so-called null model with no independent variables. It shows the baseline variance components and intraclass correlations. Model 2 controls for all the other variables, except those for grandparental or parental resources. Model 3 adds grandparental variables, and finally, Model 4 parental resource variables as well (see Online Appendix Table A2 for the estimates for the non-imputed sample).

The results show that in the random effects models, grandparental ISEI and education matters only in Model 3 where parental resources are not taken into account. When parental characteristics are taken into account in Model 4, and the observed Markovian effects are controlled for, grandparental ISEI is not statistically significant anymore. In Model 4, grandparental education has only a weak influence, and the association is no longer substantially important. One year more of a grandparent's education adds 0.3 percentage points to probability to complete general secondary; thus, 10 years of grandparental education increase the probability about 3 percentage points. Further, the point estimate of grandparental education is approximately 10 times lower than that of parental education. When parental education increases by 1 year, the child's probability of completing secondary education increases by 3 percentage points. In addition, the point estimate of grandparental ISEI is more than 10 times lower than that of parental ISEI. In practice, nearly all grandparent associations that are observed in Model 3 can be explained by the observed parental characteristics included in Model 4, although still many parental level characteristics remain unobserved.

Sibling correlation (ICC siblings) is 0.36 in the baseline model and drops to 0.31 (approximately 14 per cent) when control variables and grandparental resource

Table 2. The results of random intercept LPMs predicting grandchildren's general secondary attainment

	1	2	3	4
GP ISEI (std.)			0.0240*** 0.0027	0.0023 0.0025
GP education (years)			0.0196*** 0.0010	0.0038*** 0.0009
Parental ISEI (std.)				0.0433*** 0.0025
Parental education (years)				0.0375*** 0.0009
Family income (std.)				0.0464*** 0.0023
Aunts/uncles education				0.0043*** 0.0005
GP-GC shared life		0.006 0.0010	0.0032*** 0.0010	0.0001 0.0009
Firstborn		0.1090*** 0.0041	0.1016*** 0.0041	0.0714*** 0.0040
Thirdborn or later-born		-0.1094*** 0.0066	-0.1003*** 0.0066	-0.0614*** 0.0065
Female		0.1688*** 0.0034	0.1696*** 0.0034	0.1728*** 0.0033
Year of birth		-0.0069*** 0.0005	-0.0084*** 0.0005	-0.0109*** 0.0005
Year born: 1976–1990		0.0465*** 0.00645	0.0485*** 0.00642	0.0423*** 0.00618
Rural		-0.0384*** 0.0051	-0.0225*** 0.0051	0.0223*** 0.0048
Non-intact family		-0.1428*** 0.0042	-0.1440*** 0.0042	-0.1027*** 0.0040
Mother's age birth		0.0229*** 0.0005	0.0223*** 0.0005	0.0136*** 0.0005
Maternal side		0.0024 0.0039	0.0024 0.0039	0.0034 0.0036
Sibling number		0.0142*** 0.0018	0.0114*** 0.0018	0.0072*** 0.0017
Cousin number		-0.0039*** 0.0004	-0.0031*** 0.0004	-0.0030*** 0.0004
Constant	0.4825*** 0.0022	13,3156*** 0.9841	16,2068*** 0.9801	21,0462*** 0.9353
Var(siblings)	0.0363*** 0.0019	0.0238*** 0.0016	0.0200*** 0.0016	0.0095*** 0.0013
Var(cousins)	0.0533*** 0.002	0.0489*** 0.002	0.0484*** 0.002	0.0363*** 0.002
Var(residual)	0.1597 0.0014	0.1518 0.0014	0.1517*** 0.0013	0.1517*** 0.0013
ICC siblings	0.36	0.32	0.31	0.23
ICC cousins	0.15	0.11	0.09	0.05
N	70,845	70,845	70,845	70,845

Notes: Standard errors in second row. ICC = intra class correlation.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

variables are taken into account. However, comparing the ICCs between Models 2 and 3 shows that the control variables included in the former explain most of the variation (approximately 10 per cent). When second-generation level variables are included in the model, the sibling correlation diminishes to 0.23 in Model 4, meaning that parental and aunts'/uncles' variables explain 26 per cent of the sibling similarity, even after grandparental and control variables. For the cousin correlations (ICC cousins), grandparental education and ISEI explain 18 per cent of the variation in Model 3, compared to Model 2 (ICC drop from 0.11 to 0.09), where only control variables are included to the model. When parental and aunts'/uncles' variables are included in Model 4, cousin correlation drops to 0.05 (explaining 45 per cent of the variation), meaning that parental level variables explain most of the variation.

Next, we test whether the estimates for grandparents' resources vary according to parental resources (ISEI, family income, and education) and family type. Figure 2 plots the results of the interaction models and displays them as predicted probabilities for children's general secondary attainment. In Figure 2, we show the lowest 5 percentiles and highest 95 percentile of the distribution for grandparental and parental ISEI and education. Online Appendix Tables A3a–3h show the

estimates of the linear predictions for the main and interaction effects. According to the results, the importance of grandparental resources for children's education attainment does not seem to vary according to parental resources. The only statistically significant interaction is the one between family type and grandparental education, but even this association is weak. On average in non-intact families, children are 0.3 percentage points more likely to achieve general secondary education when grandparental education increases 1 year. Thus, 10 years of education, which is the total range of grandparental education (from 7 to 17), increase children's probability to complete general secondary only by 3 percentage points in the non-intact families. This rather weak effect nonetheless supports the stabilizer hypothesis in the non-intact families, while this is not the case for the statistically non-significant interaction between grandparental ISEI and family type.

Overall, the results from the random effects models suggest that the assumption about the growing stabilizer role of grandparents' resources has only a very limited role in Finland. Additionally, the results do not provide much support for the legacy effect hypothesis, because the magnitude of the statistically significant estimates for grandparents' education appears to be relatively weak.

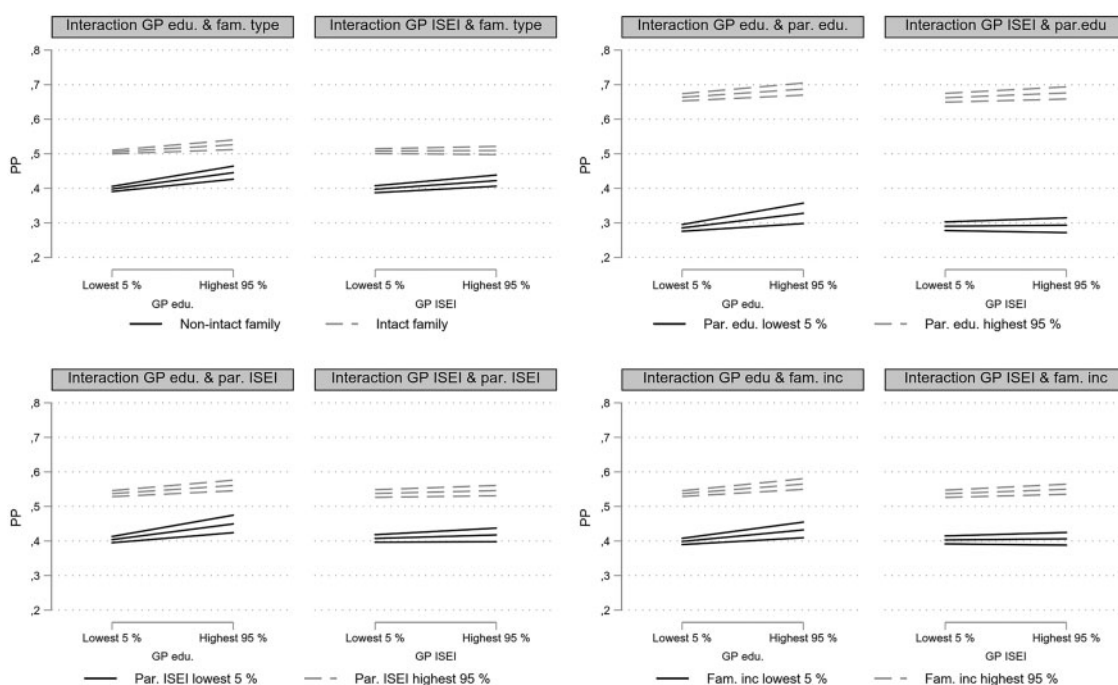


Fig. 2. Interaction effects of parental resources and dissolution with grandparents' resources, random effect models

Grandparental Exposure

Because random effects models do not take into account all the unobserved heterogeneity at the parental level, even these interactions may just reflect omitted variable bias at the parental level (i.e. all the parental characteristics shared by siblings are not controlled for). Next, we analyse the effects of grandparental exposure using sibling fixed-effects models, controlling for the remaining, unobserved Markovian processes entirely.

Table 3 reports the main results for these analyses. In Models 1 and 2, we use the Grandparent-grandchild shared lifetime (GP-GC shared lifetime) variable that is based on the number of overlapping years between the grandchild and the longest living grandparent from either the maternal or paternal side (ranging from 0 to 16). In Models 3 and 4, we use the GP-GC shared lifetime variable that is based on the total number of years of shared lifetime between the grandchild and both grandparents from either the maternal or paternal side (ranging from 0 to 32). Models 1 and 3 do not include control variables, while in Models 2 and 4, we add observed controls that vary between siblings. Table 3 shows that grandparental exposure is statistically significant in all models, although adding the control variables doubles the standard errors. However, the estimate is barely changed. Models 1 and 2 show that on average, a 1-year increase in the shared lifetime of the longest living grandparent increases the probability of the grandchild graduating from general secondary school by

approximately 1.1 percentage points. Thus, the difference between a shared lifetime of 1 year versus 16 years is more than 16 percentage points. Similarly, Models 3 and 4 show that a 1-year increase in the shared lifetime with both grandparents (total number of years) increases the probability of the grandchild graduating from general secondary school by approximately 0.7 percentage points. Thus, according to the sibling fixed effects models, taking into account the unobserved heterogeneity at the family level, it can be concluded that the exposure effect is supported as predicted in *Hypothesis 3*.

Because the shared lifetime variables in Table 3 have different ranges and thus are not comparable, we standardized both variables. The results based on the standardized variables are reported in Online Appendix Table 4. When shared lifetime is measured as the total number of years for both grandparents, the effect is somewhat larger than when the shared lifetime variable is based on only the longest living grandparent. Therefore, in regard to the exposure effect, having two grandparents alive may have a greater effect on the grandchild than having only one grandparent alive. However, the differences between the estimates are not statistically significant.

Next, we test the kin hypothesis together with the exposure effects. Table 4 reports the results of grandparental exposure by grandparental type. In both models, we see that none of the exposure effects of grandparents are statistically significant, and the effects are much smaller than those reported in Table 3. The average exposure

Table 3. The results of sibling fixed effect LPMs predicting grandchildren's general secondary attainment

	1	2	3	4
GP-GC shared life	0.012*** 0.002	0.011* 0.004	0.006*** 0.001	0.007* 0.003
Female		0.197*** 0.013		0.199*** 0.014
Family income (std.)		0.005 0.016		0 0.016
Firstborn		0.075*** 0.016		0.076*** 0.016
Thirdborn or later-born		−0.032 0.021		−0.041 0.021
Mother's age at birth		0.003 0.003		0.011** 0.004
Year born: 1976–1990		0.132*** 0.026		0.135*** 0.026
BIC	2,426.9	2,078.3	2,434.6	2,112.5
N	5,117	5,117	5,117	5,117

Notes: Standard errors in second row.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Models 1 and 2 display GP-GC shared life for the longest living grandparent from maternal or paternal side (range 0–16). Models 3 and 4 display GP-GC shared life as the total years between grandparents and grandchild from maternal or paternal side (range 0–32). Dependent variable children's general secondary attainment.

Table 4. The results of sibling fixed effect LPMs predicting grandchildren's general secondary attainment when all grandparental types are in the models

	1	2
MM-GC shared life	0.0075 0.006	0.0036 0.006
MF-GC shared life	−0.0009 0.006	0.0023 0.006
FM-GC shared life	0.0067 0.005	0.009 0.006
FF-GC shared life	0.0055 0.005	−0.0021 0.006
Firstborn		0.0680** 0.022
Thirdborn or later-born		−0.0567* 0.028
Female		0.2112*** 0.018
Family income		0.0502 0.029
Year born: 1976–1990		0.1903*** 0.04
Mother's age at birth		−0.0005 0.007
BIC	1,489.928	1247.665
N	3,053	3,053

Notes: Standard errors in second row.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

effect of the father's father is even negative. These models provide little further information to explain why grandparental average exposure is positive in Table 3.⁴

The Size of the Extended Family Network and Parental Resources

Next, we study whether grandparents' and grandchildren's shared lifetime is dependent on the size of the (extended) family. To do this, we interact grandparents' shared lifetime with the number of cousins, aunts/uncles, and relatives (all cousins and aunts and uncles). It was assumed in the *Hypothesis 3a* that if the grandparents matter because they provide access to the pool of resources available through the extended family network, the positive effect of overlapping lives should become stronger if the extended family network is wider. The unreported analyses suggest that unless the effects are differentiated by the type of the grandparent, the size of the extended family network does not play much of a role. However, the conclusion changes when we differentiate the interaction by the type of a grandparent.

Table 5. Interaction effects between grandparent-grandchildren shared lifetime and number of cousins, aunts/uncles, and all relatives (cousins + aunts/uncles) predicting grandchildren's general secondary attainment. Sibling fixed interaction effects modelled separately

	Number of cousins	Number of aunts/uncles	Number of relatives
MM-GC shared life	−0.0004 <0.001	−0.0024 0.002	−0.0004 <0.001
MF-GC shared life	−0.0005 0.001	−0.0004 0.002	−0.0004 <0.001
FM-GC shared life	0.0005* <0.001	0.0025+ 0.001	0.0005* <0.001
FF-GC shared life	0.0005 <0.001	0.0026 0.002	0.0005 <0.001
N	3,053	3,053	3,053

Notes: Standard errors in second row.

+ $P < 0.10$, * $P < 0.05$.

Interaction models controls for child's sex, family income, firstborn, third-born or later-born, dummy for birth year, maternal age, and grandparent-grandchild shared life by grandparental type. Maternal and paternal side has been modelled separately. FF = father's father; FM = father's mother; GC = grandchildren; MF = Mother's father; MM = mother's mother.

Table 5 shows the positive interaction effect between the shared lifetime between father's mother's shared lifetime and the *number of cousins* as well as the number of all relatives (all cousins and aunts/uncles). Additionally, the estimate for the *number of aunts and uncles* is marginally significant ($P < 0.10$). Thus, the positive influence of a fathers' mother only becomes more important as the size of the extended family network increases. Figure 3 plots the interaction between shared lifetime and number of relatives by the type of grandparent. It shows that when siblings have 12 extended family members from the father's side, the linear effect of the father's side is on average 1 percentage point. Thus, 16 years of shared lifetime yield, on average, 16 percentages point higher probability of graduating from general secondary school. The result indicates that paternal side grandmother acts as a link between other relatives among the extended family network as *Hypothesis 3b* predicted.

To test whether the kin keeper hypothesis applies only to families with low resources, we assessed whether grandparents' and grandchildren's shared lifetime is dependent on the parental resources and separation. Table 6 reports the results of the interaction models between grandparent-grandchildren shared life and family income, parental education, parental ISEI, and parental separation by grandparental type. Exposure to the mother's mother is significant when family income or parental

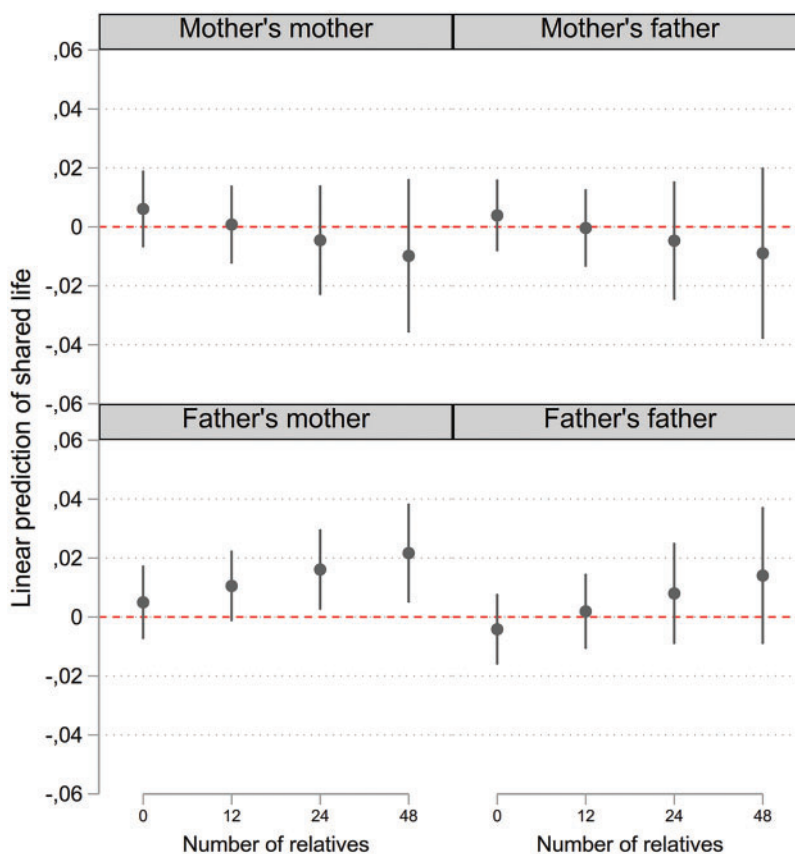


Fig. 3. Interaction effects between grandparents-grandchildren shared lifetime and number of relatives (cousins + aunts/uncles) predicting grandchildren's general secondary attainment, sibling fixed effect models

Table 6. Interaction effects between grandparent-grandchildren shared lifetime and family income, parental education, parental ISEI, and parental separation predicting grandchildren's general secondary attainment. Sibling fixed interaction effects modelled separately

	Family income	Parental education	Parental ISEI	Non-intact family
MM-GC shared life	-0.00774* 0.0033	-0.00251+ 0.0015	-0.00029* 0.0001	-0.0039 0.004
MF-GC shared life	-0.00122 0.0031	-0.00038 0.0013	-0.00017 0.0001	-0.0079+ 0.005
FM-GC shared life	0.00008 0.0033	-0.00047 0.0014	-0.00021 0.0001	-0.0015 0.004
FF-GC shared life	-0.00113 0.0031	-0.00023 0.0013	-0.00003 0.0001	-0.0033 0.005
N	3,053	3,053	3,053	3,053

Notes: Standard errors in second row.

+ $P < 0.10$, * $P < 0.05$.

Interaction models controls for child's sex, family income, firstborn, thirdborn or later-born, dummy for birth year, maternal age, and grandparent-grandchild shared life by grandparental type.

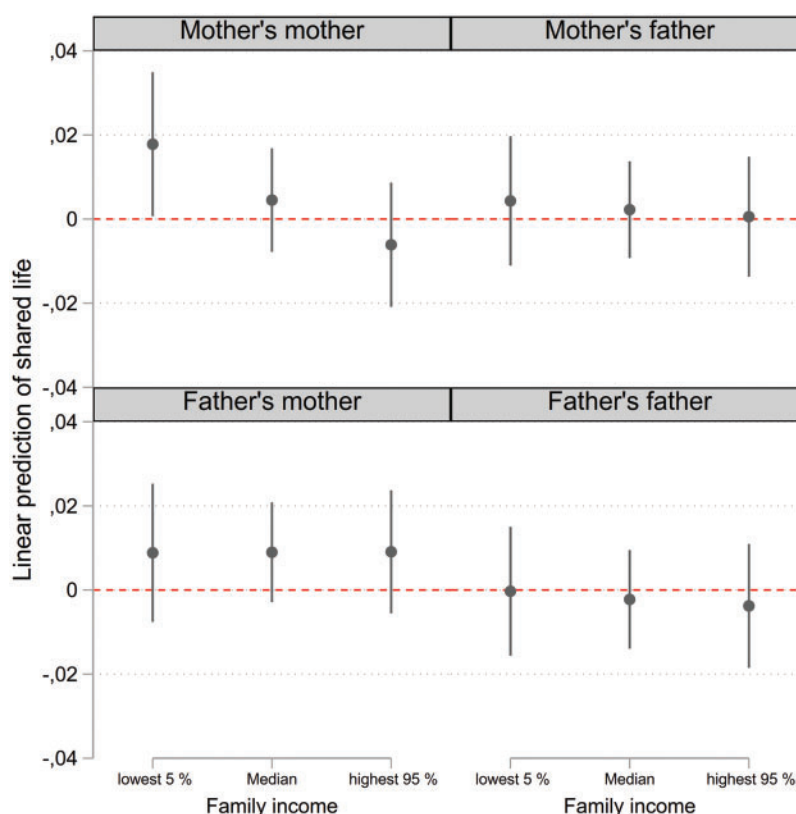


Fig. 4. Interaction effects between grandparents-grandchildren shared lifetime and family income predicting grandchildren's general secondary attainment, sibling fixed effect models

status is low. This means that the positive effect of the mother's mother is restricted to low-resource families. Figure 4 illustrates the interaction between grandparent-grandchildren shared life and family income. It shows that the linear effect of the mother's mother exposure is on average 2 percentage points—although the confidence intervals are admittedly rather large—when income of the family is in the lowest 5th quantile but is insignificant when the family income is in the highest 95th quantile.

These results support the exposure hypothesis but are conditional on the type of grandparent, the size of the extended family network, family income, and parental socioeconomic status. As suggested by the extended family network hypothesis, the shared lifetime with the grandmother from the paternal side gives access to the pool of resources of the extended family, but the shared lifetime with the grandmother from the maternal side compensates for low family resources, as predicted by the kin keeper hypothesis.

However, because our data set is rather small for the sibling fixed-effects models, it should be noted that confidence intervals grow rather wide, and some point

estimates are only weakly significant in the models, although many tests have been conducted. Thus, our results should be interpreted cautiously.

Robustness Analyses

For sensitivity purposes, we run all main random and fixed-effects models using multilevel logit regression models with similar results, reported in the results section (see Online Appendix Table A4a and 4b).

We also test whether grandparent-grandchildren shared lifetime varies according to grandparents' education and socioeconomic status (ISEI score), because exposure to the shared lifetime of grandparents with greater resources would influence siblings' educational attainment more than grandparents with fewer resources. In particular, higher grandparental education should have an impact if the effect of the shared lifetime was related to cultural capital. Grandparental socioeconomic status should have an effect if the results could be explained by grandparents' economic standing. To conduct these robustness tests with as large a sample as

possible, we select the highest education level and ISEI from the paternal or maternal side grandparents. [Online Appendix Table A5](#) shows the results of these tests. We do not find any statistically significant interactions, and in general, the estimates are small. Thus, we conclude that grandparental economic or educational resources are not moderating the grandparental exposure effect on grandchildren's educational attainment.

We also test whether grandparent–grandchildren shared lifetime varies according to the grandparents' age at the grandchild's birth. With sibling fixed-effects models, it can be argued that grandparental age matters for how long grandparents can have an impact on grandchildren. For instance, grandparental age can be considered as a proxy measure for grandparental health (although far from being a perfect indicator for that because our register data do not consist of health information). [Figure 5](#) shows that there are differences in the effects of grandparental and grandchild shared lifetime by grandparental age at birth. We see significant slope only for those grandparents who were younger than 70 when children were born, but no significant slope for those who

were older. This indicates that grandparental exposure is dependent on grandparental age, and older grandparents are unlikely to affect grandchildren's education because of their poorer health. In fact, some previous studies suggest that the old grandparents may even compete over the resources of the parents with the grandchildren ([Tanskanen, Danielsbacka and Erola, 2017](#)). Such findings give support for both the extended family network and kin keeper hypotheses. Grandparents who are older may have too many health problems to be involved in their grandchildren's lives and may no longer be a significant part of the family network.

Further, we also analysed interaction between grandparent–grandchildren shared lifetime and birth order and number of siblings. Birth order may matter because the earlier-born sibling may have received more grandparental investment compared to later-born siblings, and families with fewer children may benefit more from 'grandparenting' ([Coall and Hertwig, 2010](#)). However, the interaction effects of birth order or the number of siblings was not statistically significant (see [Online Appendix Table A6](#)).

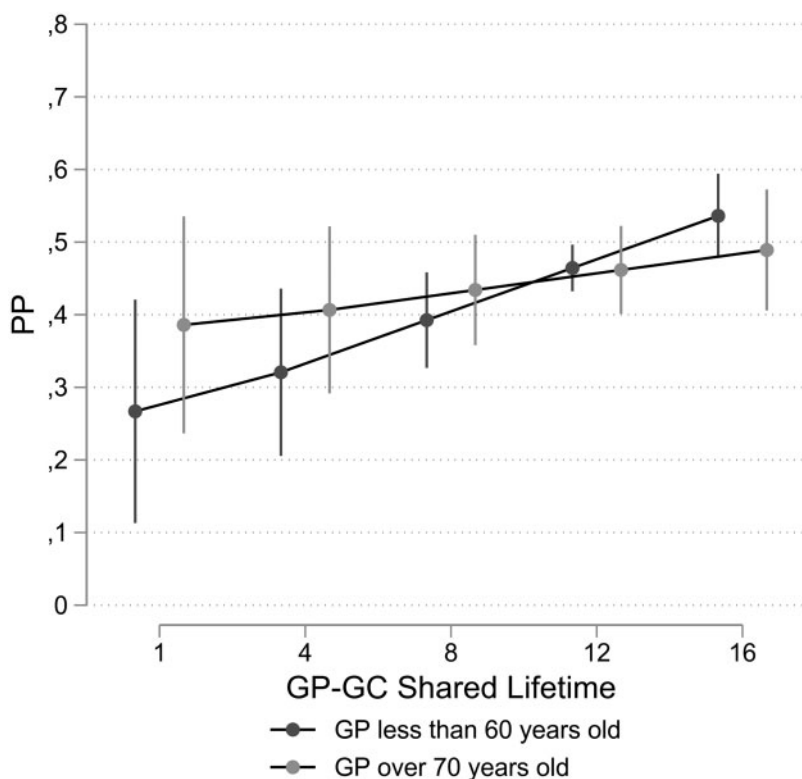


Fig. 5. Interaction between grandchild-grandparent shared lifetime and grandparental age at grandchild's birth, sibling fixed effect model

Discussion

In this study, we have investigated four potential explanations for the grandparent effects on multigenerational attainment. Our results provided only very weak support for legacy effects. Once the Markovian observed effects were controlled for, the positive association of grandparents' education becomes very small and the influence of status vanishes. This finding is in line with the previous results, showing only a small positive effect of grandparents' resources on grandchildren's adult attainment in Finland (Erola and Moisio, 2007). These results may simply be explained by a number of unobserved Markovian processes that still remain uncontrolled in the random effects models.

Interestingly, we found evidence that grandparental exposure is more important than grandparents' resources on grandchildren's general secondary school attainment. The effect of grandparents' exposure is conditional on grandparental type, family resources and number of relatives. Furthermore, our robustness analyses show that grandparental exposure is dependent on grandparental age, with no effects found for older grandparents.

The effect of maternal side grandmother exposure varies according to the resources of the parents (family income and socio-economic status). Hence, maternal grandmother exposure influences only families with low-income and socio-economic status. This is partially in line with Bengtson's (2001) assumption about the importance of grandparents in times of need but more in a way that is expected in the evolutionary literature on kin-specific grandparent effects (Lussier *et al.*, 2002; Sear and Coall, 2011). This finding provides evidence for *compensation* (see Erola and Kilpi-Jakonen, 2017). Linking this compensatory effect directly to grandparents is in line with the previous findings on the compensatory effects of extended family members from the United States (Jaeger, 2012).

Most interestingly, and as a new contribution to the literature, we found a positive interaction between the shared life of the paternal side grandmother and the number of relatives (cousins and aunts/uncles). These findings particularly indicate the importance of *paternal* side grandmothers in maintaining the extended family network. The finding suggests that paternal grandmothers provide access to the family's pool of resources through the relatives, while the maternal side grandmother seems to be more important when family resources are low. These kin-specific differences may explain why grandparents' resources, on average, matter only a little.

While the effects of grandfathers are somewhat similar to those of grandmothers in the case of exposure, the effects of the grandfathers are non-significant in all cases. This is line with previous studies that have shown that grandmothers typically are more inclined to invest in grandchildren than grandfathers are (Perry and Daly, 2017).

While supporting some aspects of Bengtson's (2001) argument about the importance of grandparents as stabilizers for increasingly turbulent immediate families, our findings limit the original (rather broad) argument in an important manner. There was only a weak interaction between parental separation and grandparental education, and the other interaction effects between parental resources and the grandparent's resources were both small and statistically insignificant. Additionally, the resources of the grandparents themselves in the sibling fixed-effects models were insignificant.

Previous multigenerational stratification studies have investigated the associations between the socio-economic attainments of grandparents and grandchildren, with mixed results. Although some have detected that grandparental status correlates with grandchildren's status (Modin, Erikson and Vägerö, 2012; Chan and Boliver, 2013), others have not found such a correlation (Warren and Hauser, 1997). The current results suggest that perhaps the most important reason for the mixed results is that the previous multigenerational stratification studies have almost solely concentrated on the socioeconomic characteristics of the grandparents, which tend to be relatively small. Further, although previous studies have found fairly consistent null results for the physical proximity and contact between grandchildren and grandparents, they have missed the exposure effect, not requiring a direct contact or resources of the grandparents themselves at all but relying on grandparents' importance in maintaining the extended family network.

Even though register data and sibling fixed-effects models can be considered as giving reliable results, this study obviously has its limitations. For instance, we have not been able to take grandparental health directly into account. However, we find a significant interaction effect between grandparental age at child's birth and shared lifetime, which indicates that grandparental health may modify impact in the exposure effect. Further, the death of a grandparent can produce stress for both parents and grandchildren, and this stress may have heterogeneous effects according to age.

It has been noted that sibling fixed-effects models can lead to biased estimates if confounders are not completely shared among siblings (see Frisell *et al.*, 2012). We have taken account of some of these confounders, however.

For instance, siblings' birth weight and health status, which vary between siblings and influence their education, cannot be controlled with our dataset. In the sibling fixed models, we were able to include only the families with two or more siblings, and those siblings who differ by grandparental shared lifetime. This might bias the results from the fixed effect samples. The sensitivity analyses reported in the Appendices suggest that these are not major problems in our case. Despite this, the fixed-effects sample sizes are rather small in our study which may lead to false negative conclusions. The analyses should thereby be replicated with larger data sets.

Our study shows—like earlier studies elsewhere—that the associations between grandparental resources and grandchildren's socioeconomic attainment in Finland, if found at all, are small (Erola and Moisio, 2007; Anderson, Sheppard and Monden, 2018). The present study has extended the previous multigenerational stratification research on kin influences by analysing the effect of shared lifetime between grandparents and grandchildren on educational attainment among grandchildren. Previously, it has been argued that the importance of multigenerational relations at the societal level should improve with the increased number of shared years between generations (Bengtson, 2001; Coall and Hertwig, 2010; Mare, 2011). Our results indicate that grandchildren benefit more, the more shared years they have with their grandparents, and this positive effect is not much dependent on grandparents' or parents' socio-economic resources, but rather on the exposure to the grandparents, observed as their overlapping years alive. Grandmothers in particular appear to be the knot that ties the extended families together.

Notes

- 1 We also tested to include grandparental education in the models as a categorical variable, and it showed a linearly changing association.
- 2 The other option would be to measure grandparental ISEI and education at early childhood. Our data set includes some yearly gaps (information available from 1980, 1985, and annually from 1987 onwards only), making the siblings less comparable if we measured grandparental ISEI and education at early childhood. However, it is unlikely that grandparental status or education would change during the childhood and youth of the grandchildren. An earlier study has shown that even the effect of parental status does not change much when children are growing up (Erola, Jalonen and Lehti, 2016).

- 3 A sum of co-residential father's and mother's taxable labor and entrepreneurial income.
- 4 In Online Appendix Table 4d, we replicated the analyses shown in Table 3 using the smaller full-information fixed-effects sample. The results show that without control variables, the estimates are very much in line with the estimates shown in Table 3. However, after the control variables are added, shared lifetime estimates are no longer statistically significant, and the effect sizes are smaller than in Table 3. This finding suggests that the full-information sample lacks the statistical power needed to provide entirely overlapping results with the fixed-effects sample used in the analyses in Table 3.

Supplementary Data

Supplementary data are available at ESR online.

Acknowledgement

This study has been presented in annual meeting of Population Association of America (PAA) in April 2017, Nordic demographic conference in June 2017 and “Multi-generational social mobility workshop” organized by the FAMSIEMATTERS project at University of Oxford in September 2017. The authors are grateful for all the helpful comments that the authors received in these events. The authors also want to thank three anonymous referees for their valuable comments and suggestions.

Funding

This work was supported by the European Research Council [grand number ERC-2013-CoG-617965].

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